

A taxonomic and biological review of the tetramoriine ant genus *Rhoptromyrmex* (Hymenoptera: Formicidae)

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ABSTRACT. Available data on the tetramoriine ant genus *Rhoptromyrmex* Mayr are reviewed. The genus is redefined for all castes and the monotypic genus *Hagioxenus* Forel, formerly placed in the *Monomorium*-group, is synonymized with *Rhoptromyrmex*. A new species (*caritus*) is described from Uganda and keys to known workers, females and males are presented. Nest founding by the females, two of which appear autoparasitic and two of which are inquiline, is discussed and the evolutionary pathway of inquilines reviewed. Current taxonomic data on all species are summarized.

Introduction

The tetramoriine ant genus *Rhoptromyrmex* Mayr is a compact assemblage of nine species, closely related to the very large genus *Tetramorium* Mayr (Bolton, 1976). *Rhoptromyrmex* species are very widely distributed in the Old World tropics and subtropics, with most species (five) occurring in the Afrotropical zoogeographical region. Three more species occur in the Oriental and Indo-Australian regions, of which two extend their range to the Cape York Peninsula of Australia. A final species is known only from a single collection made many years ago in Israel.

Two *Rhoptromyrmex* females are known to be workerless inquilines in the colonies of other ground nesting ant species, and two others apparently spread by autoparasitism and colony fission. Females of the remaining five species show morphological adaptations characteristic of socially parasitic forms, which

imply that they may begin new colonies by some form of temporary social parasitism or by some other abnormal nest founding technique.

In species where workers are present, Brown (1964 and pers. comm.) notes that in *globulinodis* in Zimbabwe extensive and populous nests containing thousands of workers are constructed in the soil beneath rocks and boulders of various sizes, which were mostly firmly embedded in the turf. The Oriental and Indo-Australian species *melleus* and *wroughtonii* form high colonies in the soil or under the bark of rotten logs and in the surrounding earth. In both cases the nests are surmounted by an enormous irregular mound of excavated soil particles and have numerous entrances. The earthworks above the nest are beaten down by heavy rains but are then reconstructed by the ants. A nest of *wroughtonii* examined by William L. Brown, Jr at Mou Man Shan, Sichuan Province, China, 'attracted attention at first because of its size (up to 30 cm maximum height) and fantastically castellated and multi-turreted structure, with ten or more lipped towers projecting up to 10 or

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15 cm from the main mass of the mound, with round apical entrance holes, and also a few broad entrance slits between the turrets. During the daylight hours, few of the yellowish-tan workers came or went from this nest, but a visit on a warm rainless night in mid-October revealed long columns of workers leaving and entering this nest, and foraging on the surrounding ground and shrubs. A heavy rain shortly after this reduced this castellated structure to a low, rounded mound, but at last viewing the structure was quickly being restored to its original complex state.' *Rhoptromyrmex* workers are general feeders and collect living and dead arthropods, tend homopterous insects for their honeydew both above and below ground, and feed at plant nectaries (Brown, 1964).

Morphologically *Rhoptromyrmex* species where all three castes occur show a relatively uniform worker habitus and a reasonably stable set of characters in the males. However, the reproductive females are very strange and, within the combination of characters which defines the genus, are highly divergent in body form, showing a marked degree of interspecific and intraspecific variation which in some species amounts to female polymorphism.

The taxonomy of the genus was first investigated by Brown (1964) and later reviewed, along with other smaller tetramoriine genera, by Bolton (1976). These studies resulted in the synonymy under *Rhoptromyrmex* of two earlier genus-level names *Acidomyrmex* Emery and *Ireneella* Donisthorpe. A current investigation of genera constituting the *Monomorium* group, as most recently defined by Ettershank (1966), has revealed that the monotypic genus *Hagioxenus* Forel is not a monomoriine but is correctly placed as a junior synonym of *Rhoptromyrmex*, its type-species, *schmitzi*, apparently being closest related to *R.opacus*.

In the present study the genus *Rhoptromyrmex* is redefined for all castes and the current genus-level synonymy discussed. A revised key to the workers and newly constructed keys to the females and males are presented, together with a synonymic synopsis of the known castes of the various species, their distribution, and notes on variation within the castes. Nest founding techniques by newly mated females are discussed and an expanded tabulation of the suspected evolutionary stages of nest

foundation which lead from claustral to extreme inquilinism, is given. The paper concludes with a summary of the current taxonomic status of each species, with revised diagnoses.

It is hoped that this synopsis of our rather meagre knowledge of this interesting small genus will stimulate investigation of the ecology and behaviour of this widespread but little understood group of ants.

Rhoptromyrmex Mayr

Rhoptromyrmex Mayr, 1901: 18. Type-species: *Rhoptromyrmex globulinodis* Mayr, 1901: 20; by subsequent designation of Wheeler, 1911: 172.

Hagioxenus Forel 1910: 8. Type-species: *Hagioxenus schmitzi* Forel, 1910: 8; by monotypy. **Syn.n.**

Acidomyrmex Emery, 1915: 191 [as subgenus of *Rhoptromyrmex*]. Type-species: *Rhoptromyrmex wroughtonii* Forel, 1902: 231; by original designation. [Synonymy by Brown, 1964: 11.]

Ireneella Donisthorpe, 1941: 175. Type-species: *Ireneella papuensis* Donisthorpe, 1941: 175 (= *Rhoptromyrmex melleus* (Emery), 1897: 586); by original designation. [Synonymy by Bolton, 1976: 298.]

Diagnosis of worker (Figs. 1, 5, 12, 20, 21, 25, 31, 32). Myrmicine ants with the following combination of characters.

(1) Mandibles with a large apical and smaller preapical tooth, these followed by a much smaller third tooth and a row of 4–6 denticles (total dental count 7–9).

(2) Palp formula 3, 2 or 4, 2.

(3) Head cordate or subcordate in outline (Figs. 5, 25, 31), much broader behind than in front and with convex sides.

(4) Anterior clypeal margin broadly convex medially and overhanging the basal borders of the mandibles; not notched at its midpoint.

(5) Lateral portions of clypeus modified into a narrow low ridge or wall in front of the antennal insertions.

(6) Clypeus broad posteriorly and broadly inserted between the widely separated frontal lobes.

(7) Frontal lobes small, only partially covering the antennal insertions.

(8) Frontal carinae and antennal scrobes absent.

(9) Antennae 11- or 12-segmented, with a strong club of 3 segments apically.

(10) Eyes situated behind midlength of sides of head.

(11) Metapleural lobes present, rounded, very narrow in some species.

(12) Spiracle low on the side of the propodeum, almost at the junction with the metapleuron and usually just behind the propodeal midlength.

(13) Ventral alitrunk with an extensive U- or V-shaped open articulatory excavation for the petiole, which runs from the postero-ventral margin to about the midpoint between the middle and hind coxae, terminating at the metasternal process.

(14) Metasternal process present, in profile appearing as a dentiform or lobiform prominence on each side at the apex of the petiolar articulatory excavation, and usually drawn out posteriorly into a narrow flange which borders the excavation.

(15) Ventral margin of petiole usually convex and keel-like, the petiolar spiracle at the level of the anterior portion of the node, not on the peduncle in front of the node.

(16) Apex of sting with a small triangular or dentiform lamellate appendage which is approximately at a right-angle to the long axis of the shaft.

Diagnosis of female (Figs. 3, 4, 7–11, 15–19, 22, 24, 27, 28). Myrmicine ants with character combination of worker, but:

(1) Dental count reduced to 5–6 in *transversinodis*, otherwise as worker.

(3) Head not cordate as worker; ocelli present.

(4) In species with subfalcate mandibles the clypeus does not overhang the basal border of the mandibles (Figs. 7, 8).

(10) Eyes at or slightly in front of the midlength of the sides of the head. Eyes usually with projecting hairs, which are absent in workers.

(13)+(14) Confirmed as for worker in *opacus*, *globulinodis* and *mayri* but metasternal process less well developed.

(15) Ventral margin of petiole in profile more strongly keel-like than in worker.

Additional characters of female: Alitrunk with full complement of flight sclerites; parapsidal grooves present on mesoscutum. Winged when virgin, venation as in Fig. 19. Radial cell usually open but may be closed. Cross-vein m-cu absent in *mayri*.

Diagnosis of male (Figs. 2, 6, 13, 14, 23, 26, 29, 30). Myrmicine ants with the following combination of characters.

(1) Mandibles with 4–7 teeth, decreasing in size from apex to base or arranged as in worker.

(2) Palp formula 3, 2; confirmed for *globulinodis*, *transversinodis*, *melleus*.

(3) Anterior clypeal margin evenly broadly convex and overhanging the basal borders of the mandibles.

(4) Clypeus broad posteriorly and broadly inserted between the antennal sockets.

(5) Second funicular segment of antennae a very long fusion-segment.

(6) Antennae basically with 9 segments (Figs. 14, 26, 30) but partial freeing of apical member of the fusion-segment or partial fusion of the next antennomere may give an ambiguous count of 8, 9, or 10 segments in some.

(7) The three apical segments of the funiculus forming a club.

(8) Eyes with projecting hairs present except in *transversinodis*.

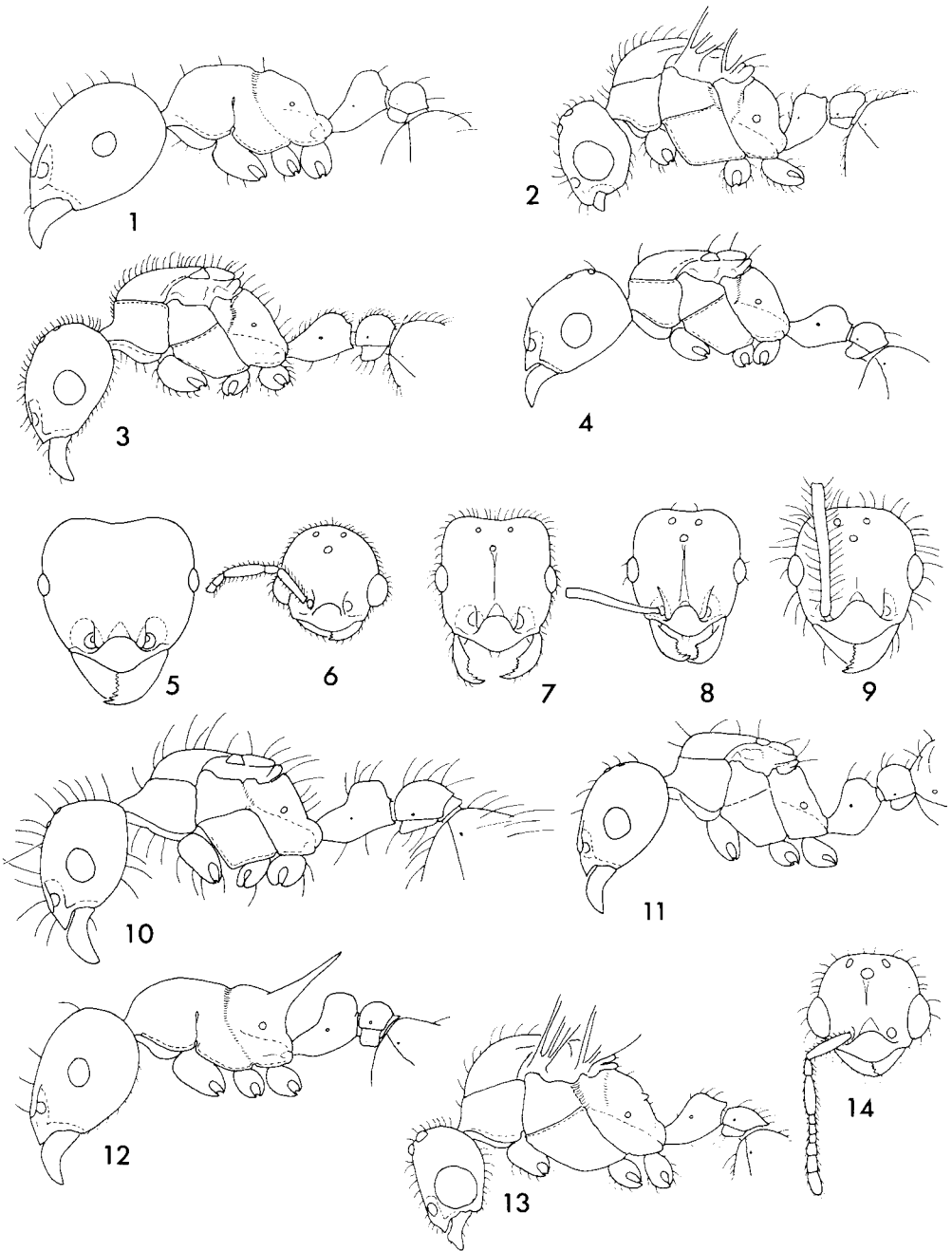
(9) Parapsidal grooves present on mesoscutum but notauli present or absent.

(10) Venation as in female.

Characters 11, 12, and 15 of worker diagnosis are shown in males.

Comments

Rhoptromyrmex is a tetramoriine genus, as that group was defined by Bolton (1976). As such the workers and females show the characteristic dentition, clypeal structure, palp formulae and specialized sting appendage noted there; and the males possess the diagnostic elongate fusion-segment in the antennal funiculi. More recent work indicates that position of spiracles and form of the alitrunk-petiole articulation are also important in isolating the tetramoriines, as reflected in the revised di-



FIGS. 1-14. *Rhoptromyrmex* species. 1-7, *R. opacus*; 1-4, body profiles of: 1, worker; 2, male; 3, 4, females; 5-7, heads of: 5, worker; 6, male; 7, female. 8-9, heads of: 8, *schmitzi* female; 9, *mayri* female. 10-13, body profiles of: 10, *mayri* female; 11, *schmitzi* female; 12, *melleus* worker; 13, *melleus* male. 14, head of *melleus* male. (Scale: Fig. 5 HW=0.80 mm.)

agnoses above. Keys to separate the tetramoriine genera were included in Bolton (1976, 1980).

The genus-level synonyms

The earlier genus-level synonyms of *Rhoptromyrmex*, namely *Acidomyrmex* and *Ireneella*, have been discussed by Brown (1964) and Bolton (1976). In brief, *Acidomyrmex* was proposed for the then known species in which the worker had propodeal spines present. Patently this was an artificial division as spines were present in workers of *melleus* and *wroughtonii* but not in their females, whilst the female of *transversinodis* has the propodeum armed but its worker does not. *Ireneella* was the name proposed by Donisthorpe (1941) for a series of tetramoriine males from New Guinea. These are the males of *R.melleus* and so *Ireneella* fell into the synonymy.

Forel (1910), when describing *Hagioxenus*, considered it to be close to *Myrmoxenus* Ruzsky and *Epixenus* Emery (the latter now being a synonym of *Monomorium*) but to differ from these two by the form of the clypeus and propodeum. Unfortunately he did not give his reasons for this opinion, nor did he give differentiating notes. As *Myrmoxenus* is a leptothoracine and *Epixenus* (= *Monomorium*) a monomoriine, then evidently *Hagioxenus* cannot be closely related to both of these, and only resembles both in convergently acquired characters, which are extensively developed in myrmicine ants.

Forel (1917) listed *Hagioxenus* in tribe Solenopsidini, subtribe Monomoriini, and this placement was adopted by both Wheeler (1922) and Emery (1922). The fact that both authors uncritically accepted this placement tended to imply, even if unconsciously, that the affinities of *Hagioxenus* lay with the monomoriines. The situation rested there until Ettershank (1966) revised the *Monomorium* genus-group. Being unable to examine the holotype, and still the only known specimen of *Hagioxenus schmitzi*, he pointed out that the available descriptions of *Hagioxenus* did not even allow a calculated guess at its real affinities, and so he was forced to leave it in the *Monomorium*-group. He noted however that Brown (1964) had previously determined a

relationship between *Hagioxenus schmitzi* and *Rhoptromyrmex mayri*, going so far as to transfer *mayri* into *Hagioxenus*. Some years later, during his study of the tetramoriines, Bolton (1979) dissected two syntypic females of *mayri*, and the results showed that it was in fact a tetramoriine, correctly placed in *Rhoptromyrmex* where it had first been described. Bolton (1979) formally returned *mayri* to *Rhoptromyrmex*, leaving *schmitzi* again as the sole constituent species of *Hagioxenus*.

Wilson (1984) included *Hagioxenus* in his review of parasitic pheidolines as a problematical genus. He did not see the holotype of *schmitzi* but correctly expressed doubt that it had any pheidoline affinities. He stated, however, that the holotype female of *schmitzi* was alate, which is not the case. The specimen had already lost its wings when first captured and in the original description Forel (1910) says, 'les ailes manquent', and later, 'ailes tombées'.

On present examination the holotype female of *schmitzi* is determined as belonging to the genus *Rhoptromyrmex* where it appears to be close to, or at least shows the same adaptive modifications as *R.opacus*. All characters diagnostic of *Rhoptromyrmex* are present and visible except for the sting, which cannot be examined as the apex of the gaster is much damaged in the holotype and the sting missing. I predict that if fresh females of *schmitzi* are found they will have a small apicodorsal triangular lamellate appendage present, like all other *Rhoptromyrmex* females and workers.

This association of *schmitzi* with *Rhoptromyrmex* shows that Brown's (1964) insight into the relationship between *mayri* and *schmitzi* was fundamentally correct but, because only females of each were known and as both were collected as inquiline in the nests of other ant species, he chose to take *mayri* out of *Rhoptromyrmex* rather than to add *schmitzi* to it.

Keys to *Rhoptromyrmex* species

Workers (not known in *caritus*, *mayri*, *schmitzi*)

1 Propodeum armed with a pair of spines or teeth (Figs. 12, 20)..... 2

- Propodeum unarmed and rounded (Figs. 1, 21, 32) 4
- 2 Antennae with 11 segments *critchleyi*
- Antennae with 12 segments 3
- 3 Propodeal spines very long (Fig. 12), about twice as long as the distance between the centres of their bases; the spines approximately as long as the maximum pronotal width *melleus*
- Propodeal spines much shorter (Fig. 20), variable in length but less than twice as long as the distance between the centres of their bases; the spines shorter than the maximum pronotal width *wroughtonii*
- 4 Alitrunk and usually also the head with dense opaque reticulate-punctate sculpture throughout. Maxillary palp with 4 segments *opacus*
- Alitrunk and head in large part smooth and shining. Maxillary palp with 3 segments, only very rarely with 4 5
- 5 Postpetiole subglobular in dorsal view (Fig. 32), in profile with a prominent rounded ventral protuberance *globulinodis*
- Postpetiole much broader than long in dorsal view (Fig. 21), in profile without a prominent ventral protuberance *transversinodis*

Females (not known in *critchleyi*)

- 1 Propodeal declivity with a pair of projecting lamellae or flanges which may be fused with or separated from the metapleural lobes (Figs. 15, 22) 2
- Propodeal declivity unarmed or at most with a pair of carinae running its length (Figs. 3, 4, 10, 11, 16, 27) 3
- 2 Postpetiole in profile with a long projecting ventral process (Fig. 15). Occipital corners in profile not drawn out into large flattened lobes. Palp formula 4, 2 *caritus*
- Postpetiole in profile without a projecting ventral process (Fig. 22). Occipital corners in profile drawn out into large flattened lobes. Palp formula 3, 2 *transversinodis*

- 3 In full-face view the occipital margin of the head with a pronounced U-shaped median indentation (Fig. 28), the head relatively long and narrow. Propodeum dorsally bicarinate throughout its length, the area between the carinae shallowly transversely concave. Ventral surface of head approximately flat in profile (Fig. 27) *globulinodis*
- In full-face view the occipital margin of the head at most shallowly concave, without a U-shaped indentation (Figs. 7, 8, 9, 18), the head relatively short. Propodeum dorsally without a pair of carinae running its length. Ventral surface of head convex in profile (Figs. 3, 4, 10, 11, 16) 4
- 4 Mandibles subfalcate, in full-face view with weakly concave and somewhat oblique masticatory margins, and with a large undercurved apical tooth (Figs. 7, 8) 5
- Mandibles triangular, in full-face view with a more or less straight masticatory margin; the apical tooth enlarged but not undercurved (Figs. 9, 18) 6
- 5 Maxillary palp with 3 segments. Ventral keel of petiole relatively prominent and deep (Figs. 8, 11) *schmitzi*
- Maxillary palp with 4 segments. Ventral keel of petiole relatively evenly convex and shallow (Figs. 3, 4, 7) *opacus*
- 6 Ventral process of petiole a massively extended flange (Fig. 16) *wroughtonii*
- Ventral process of petiole a low keel-like convexity (Fig. 10) 7
- 7 Entirety of body and appendages densely clothed with long erect stout hairs; node of petiole in profile with dorsal surface flat (Figs. 9, 10) .. *mayri*
- Pilosity sparse to absent, body and appendages not clothed with long erect stout hairs; node of petiole in profile with dorsal surface evenly convex *melleus*

Males (not known in *caritus*, *critchleyi*, *mayri*, *schmitzi*)

- 1 With head in full-face view the occipital corners projecting as a low lobe on each side (Figs. 26, 30) 2

Synopsis of known castes, and distribution

Species	Worker	Female	Male	Known distribution
<i>caritus</i>		+		Uganda.
<i>critchleyi</i>	+			Nigeria.
<i>globulinodis</i>	+	+	+	Zaire to South Africa.
<i>mayri</i>		+		India.
<i>melleus</i>	+	+	+	Sulawesi, New Guinea, Cape York Peninsula of Australia.
<i>opacus</i>	+	+	+	West and Central Africa, Uganda.
<i>schmitzi</i>		+		Israel.
<i>transversinodis</i>	+	+	+	Kenya, Zimbabwe, South Africa.
<i>wroughtonii</i>	+	+	+	Oriental and Indo-Australian regions, Cape York Peninsula of Australia.

- With head in full-face view the occipital margin evenly arched-convex across its width, without lobes at the corners (Figs. 6, 14)..... 3
- 2 Dorsal outline of petiole node in profile bluntly rounded (Fig. 29). Postpetiole node in dorsal view not transversely rectangular, only slightly broader than long.....*globulinodis*
- Dorsal outline of petiole node in profile rising to a distinct peak posteriorly (Fig. 23). Postpetiole node in dorsal view transversely rectangular, conspicuously very much broader than long
transversinodis
- 3 Propodeum unarmed, evenly rounded at junction of dorsum and declivity (Fig. 2).....*opacus*
- Propodeum with a tooth or tubercle at junction of dorsum and declivity (Fig. 13)..... 4
- 4 Dorsum and sides of head with evenly distributed fine dense sculpture everywhere.....*melleus*
- Dorsum and sides of head with extensive smooth areas.....*wroughtonii*

Colony founding by *Rhoptromyrmex* females

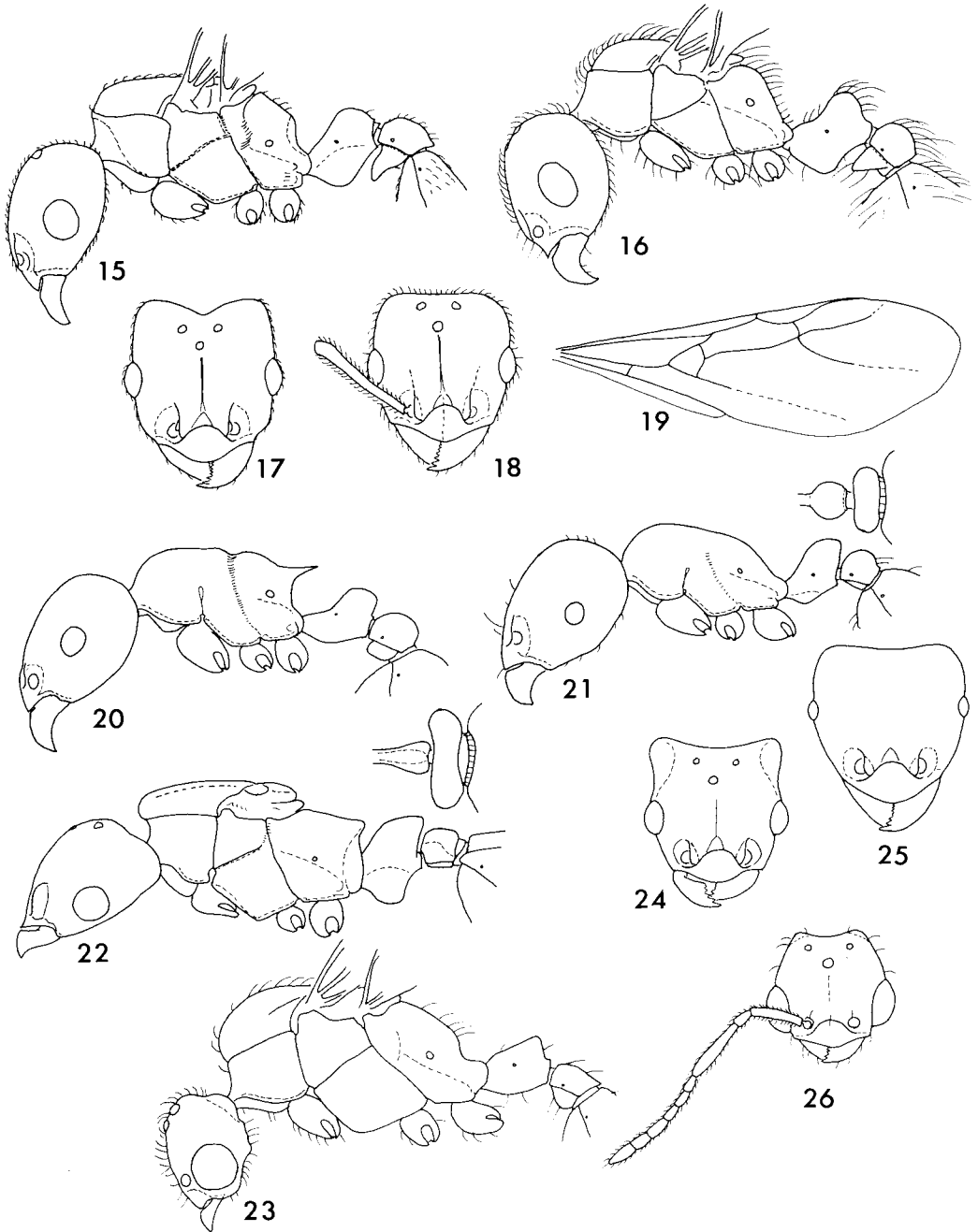
Considering the wide diversity of morphological specialization shown by the *Rhoptromyrmex* females which he had available, and observing that many of these specializations were reflected elsewhere in parasitic myrmicine females, it was logical that Brown (1964) should suggest that the females of *globulinodis*, *melleus*, *opacus*, *transversinodis* and *wroughtonii* possibly utilized, a temporary socially parasitic method of colony foundation. He envisaged the newly fertilized *Rhoptromyrmex* female entering the nest of a host species and being adopted by, or somehow cowing, the host workers. The parasitic female would then manage, in some unknown way, to usurp the position of the host's laying female and begin laying her own eggs, which would be brought to maturity by the host workers. The host female by this time being dead or non-functional, the nest would gradually fill up with the offspring of the *Rhoptromyrmex* female and, as the host workers eventually died off (there being no laying host female to replenish their numbers), the colony would eventually come to consist solely of *Rhoptromyrmex*.

Since then Professor William L. Brown, Jr (pers. comm.) has made a couple of interesting observations which imply that in at least two

species, one Oriental and one Afrotropical, colonies spread by autoparasitism followed by polygyny and subsequent colony fission, rather than by temporary social parasitism. Observing *wroughtonii* at Doi Pui near Chiang Mai, Thailand, in mid-April 1981, Brown saw about thirty alate and one dealate female of this species being carried towards the nest by workers of the same species. The females were being carried to the nest over distances of up to a metre, across fairly open soil. Brown's note continues: 'The queens were passive, carried in a ventrally-curved position, held in the workers' mandibles either by the waist (petiole) or by their own mandibles. About ten of the queens were observed to be carried by the workers directly into the nest entrance'. He continues by saying that: 'no other *Rhoptromyrmex* nests were found in the vicinity of this colony, despite a thorough search, and it is my impression that the queens were being reintroduced into their own parent nest after a brief excursion from it'.

Some years before this, in mid-March 1969, Brown had noted numerous very populous colonies of *globulinodis* under stones at Cecil Kop, Umtali, Zimbabwe. These colonies contained thousands of workers and 'hundreds of thousands of winged males and queens ... apparently close to the time when they would issue in flight from the nest'. Considering that *globulinodis* may be a temporary social parasite and that if so its likely host would be nearby, Brown made a check on 'the *Tetramorium* and other myrmicine colonies encountered'. He recalls that these were 'extremely few and weak as compared to the very large and numerous *Rhoptromyrmex* colonies, raising my doubts about how *Rhoptromyrmex* parasitism ... might prosper at this locality'.

From these observations the most likely colony founding system utilized by these two species involves autoparasitism followed by fission of the parent colony. Elsewhere in the genus females of *mayri* and *schmitzi* have both been found as workerless inquilines in the nests of radically different host species. In the case of *mayri* a number of alate females were found alive in a nest of *Pheidole latinoda* Roger. The implication is that as there were several females and they possessed wings, they represent a second (or later) generation, developed from eggs laid in the *Pheidole* nest by



FIGS. 15–26. *Rhoptromyrmex* species. 15–16, body profiles of: 15, *caritus* female; 16, *wroughtonii* female. 17–18, heads of: 17, *caritus* female; 18, *wroughtonii* female. 19, right forewing of *wroughtonii* female. 20, body profile of *wroughtonii* worker. 21–26, *R.transversinodis*. 21–23, body profiles of: 21: worker; 22, female; 23, male; 24–26, heads of: 24, female; 25, worker; 26, male. (Scale: Fig. 25 HW=0.80mm.)

an earlier inquiline female of *mayri* which had already taken over the *latinoda* colony. It also implies that *mayri* has lost its worker caste as no *Rhoptromyrmex* workers were discovered in the *Pheidole* nest. With *schmitzi*, a single dealate female was found alive in a nest of *Tapinoma erraticum* (Latreille) in Israel. Again no *Rhoptromyrmex* workers were found in the *Tapinoma* colony and, to the best of my knowledge, no *Rhoptromyrmex* workers have ever been found in Israel or its surrounding states; *schmitzi* also appears to be a workerless inquiline.

As Wilson (1971) has summarized, there is a well-defined evolutionary pathway with numerous finely graded steps leading from autoparasitism to extreme inquilinism. The *Rhoptromyrmex* species which have known or reasonably inferred colony founding techniques fall at the beginning and end of this sequence, with *wroughtonii* and *globulinodis* having autoparasitism with colony fission, and *mayri* and *schmitzi* being workerless extreme inquilines. The very existence in *Rhoptromyrmex* of these two ends of the line suggests that some of the other species, where nesting habits remain utterly unknown, may well represent intermediates in the evolutionary sequence, where temporary social parasitism would occur. If this is the case, and a colony history similar to that outlined in the first paragraph is followed, then there should obviously be a reasonably long period when mixed colonies occur, containing both the parasite's worker offspring and the remaining host workers in the nest at the same time. Unfortunately this stage of development has not been observed as yet in any *Rhoptromyrmex* species, but the microgynous female of *opacus*, with its close resemblance to the workerless *schmitzi* both in habitus and in specialized characters, must be a prime candidate for investigation.

Adapted and expanded from previous synopses, the following developmental sequence from free living to extreme inquilinism, without involving the formation of compound nests and without involving dulosis, is postulated. Extensive references and examples are cited in Wheeler (1910), Kutter (1969), Wilson (1971) and Dumpert (1978).

(1) *Claustral colony founding*. Mated female enclosed in permanently sealed cell which she does not leave during brood development.

This method is used by the vast majority of all ant species. Usually a single female is involved but exceptionally several females may combine during colony founding (pleometrosis), although in the end only one survives to become the laying female of the new colony.

(2) *Claustral with autoparasitism*. Some mated females found new colonies as in (1), but some return after mating to their nest of origin, where they are re-adopted. In this situation the re-adopted females may augment the nest's laying potential, may eventually replace the original female as she ages, or may later leave the nest by its fission.

(3) *Autoparasitism*. All mated females return to (or do not leave) the parent colony. The colony rapidly becomes polygynous and fission occurs with one or more females setting out with a number of workers to establish new colonies away from the parent nest.

(4) *Autoparasitism with out-adoption*. Most mated females return to the parent colony (as in 3) but some may be adopted by nearby colonies of the same species, leading again to polygyny and eventual nest fission.

(5) *Autoparasitism with emergent social parasitism*. Mated females may return to the parent colony (as in 3) but those which do not return enter the nest of a different (host) species. The intrusive female takes control of the nest, the host female may or may not be killed.

(6) *Temporary social parasitism with retention of functional worker caste*. Mated females always penetrate the nests of a host species. Once established the parasitic female lays eggs which give rise to functional workers as well as females and males. Host female may be killed, either by the parasite or by the host workers themselves. As in (5) the colony eventually comes to consist entirely of the parasite's offspring.

(7) *Temporary social parasitism with degenerate worker caste*. As in (6) but relatively few workers produced; the workers which are produced do not take part in any nest activities. Most eggs laid give rise to females and males; workers may be produced initially by the parasitic female, which later die off.

(8) *Inquilines, without a worker caste*. Mated parasitic female penetrates host nest, host female may or may not be killed. Eggs laid by inquiline give rise only to fresh females and males; workers are never produced. (Forms

included here fall into two groups, those showing gross anatomical modification and those without such modification.)

(9) *Ectoparasitic inquilines*. Inquilines with worker caste lost and exhibiting extreme microgyny with marked anatomical specialization. Such females ride as ectoparasites on the host and females produced within the host nest may remain after mating or fly off to find new host nests. Host female survives.

The specializations in morphology and behaviour exhibited by parasitic ants are legion. Wilson (1971) goes so far as to say that 'no two species are exactly alike in the details of their parasitic adaptation'. Certainly no single genus shows all the stages listed above, though various *Formica* species span states 1–6 inclusive, and some species utilize more than one of the listed techniques. Species of *Myrmica* and its related genera run almost the whole gamut, and *Epimyrma* spans stages 7 and 8. It should be emphasized that parasitic forms do not necessarily begin at (1) and run regularly through to (9) during their evolutionary history. The more or less stepped sequence outlined above is artificial inasmuch as it is an agglomeration of the various adaptations showed by all the forms involved. The presence at stage 7 of what appears to be two radically different groups of entities suggests that more than one mechanism is at work in triggering the development of parasitic behaviour, or that forms derived by a dulotic route or compound nest route may enter the sequence at one or more points, and be indistinguishable in their end-results from forms derived by the route postulated above.

Discussion of castes

Workers. These display a fairly uniform habitus, as indicated in Figs. 1, 5, 12, 20, 21, 25, 31 and 32. The most obvious variable character which they exhibit is the presence or absence of propodeal spines, which are lacking in the African species except for *critchleyi* but present in both species found outside Africa. Length and elevation of the spines is fairly constant in *melleus* but variable in *wroughtonii*.

The palp formula (PF) is usually 3,2 (*critch-*

leyi, *globulinodis*, *melleus*, *wroughtonii*) but appears always to be 4,2 in *opacus* (this was wrongly noted as 3,2 in Bolton, 1976). Variation may occur in populations of *transversinodis* for although PF 3,2 is almost universal a single worker examined had the left maxillary palp with 3 segments and the right with 4. Other workers from the same series had the usual 3,2. Such variability in PF count has not been observed in any other species.

Sculpture, or its lack, is quite consistent in most species, but *opacus* shows considerable variation, ranging from coarsely reticulate-punctate with overlying rugulae to almost smooth. This variation does not appear to correlate in any way with the different forms of female observed in *opacus*, but there is a remote possibility that a worker variant currently included in *opacus* may be conspecific with the *caritus* female described below. I suggest this as *caritus* and *opacus* share a PF of 4,2, and the holotype female of *caritus* was with a number of *opacus* workers collected in Ruwenzori; but it was collected as a separate sample, not in direct association with any of those workers.

Females. In comparison to the workers the morphological range of the females is very great (Figs. 3, 4, 7–11, 15–19, 22, 24, 27, 28). Most species show only a single form of female as far as is known, but *transversinodis*, *opacus*, and to a lesser degree *melleus*, each exhibit what appears to be female polymorphism. At least that is how it was interpreted by Brown (1964) and is so interpreted here. There is a small chance that these morphs represent sibling species but evidence for this is slight. Considering the eight species for which females are known, they seem to follow four adaptive lines.

(1) The females which appear morphologically closest to *Tetramorium*, hence are the most generalized, are those of *melleus*, *wroughtonii* and *caritus*, although the last two have developed large ventral processess on both petiole and postpetiole (Figs. 15, 16). In *melleus* and *wroughtonii* the postpetiole is broad in dorsal view, the alitrunk relatively short and compact, and broad across the mesoscutum. The head is characteristically tetramoriine, with triangular mandibles (Figs. 17, 18) and the eyes are at about the midlength of the sides. Only one morphological form is

known in *wroughtonii* and *caritus*, but Brown (1964) describes two forms of *melleus*, one of which is more densely hairy and more strongly punctate than the other. *R. caritus* (Figs. 15, 17) falls into the same adaptive zone as *wroughtonii* but retains propodeal armament, has 4 maxillary palp segments and is very densely sculptured. The worker of *caritus* is not known but females of *wroughtonii* and *melleus* are macrogynous, large than their conspecific workers.

(2) In *globulinodis* (Figs. 27, 28) and *mayri* (Figs. 9, 10) the alitrunk is somewhat elongated and is bilaterally compressed. The petiole is elongated and narrow from side to side, and the postpetiole is relatively narrow, being only slightly broader than long in *mayri* and longer than broad in *globulinodis*. In both the petiole peduncle has developed ventrally into a long evenly convex low keel and both have prominent blunt subpostpetiolar processes. Both species are densely hairy and in *globulinodis* the female is macrogynous. Both species retain the powerful mandibles and full complement of teeth characteristic of tetramoriine ants.

(3) *R. opacus* females (Figs. 3, 4, 7) are microgynous, distinctly smaller than the worker (Figs. 1, 5), and resemble *schmitzi* (Figs. 8, 11) so closely that by implication *schmitzi* was probably also microgynous when it possessed a worker caste. Both have subfalcate mandibles with the masticatory margin weakly concave in full-face view, and in both the blade is down-curved so that the enlarged apical tooth is curved under the remainder of the tooth row (Figs. 7, 8). Both retain the full tetramoriine dental count but in *opacus* the masticatory margin is more oblique than in *schmitzi*, so much so that a distinct gap is present basally between the mandibles and the clypeus at full closure. Eyes are at the midlength and the occipital margin is only feebly concave medially. The alitrunk is very short and compact (Figs. 3, 4, 11) and the subpetiolar process is a simple keel. The subpostpetiolar process is a thick blunt prominence. The *schmitzi* holotype has scattered long simple hairs and shows evidence of abrasion; it was probably much more hairy in life. Pilosity in *opacus* is very unstable and forms part of the polymorphism exhibited by the females.

Three forms of *opacus* female are currently

known. The first (Fig. 4) is smooth and glossy with extremely sparse pilosity. Two pairs of erect hairs occur on the head, four pairs on the dorsal alitrunk and one pair on the petiole. The eyes lack projecting hairs but fine appressed pubescence is present on the head and body. The cephalic dorsum is unsculptured except for small pits and the propodeum lacks sculpture. In the second form the head, alitrunk, petiole and postpetiole are densely clothed with short stout straight hairs which are blunt apically and have longer finer hairs amongst them. The gaster has only longer fine hairs. The cephalic dorsum is finely rugulose and shagreened to the level of the anterior ocellus and the propodeum laterally is finely irregularly rugulose. The sides of the head and the eyes have numerous blunt projecting hairs. In the third form the body is as densely hairy but all the hairs are fine and acute apically (Figs. 3, 7). As in the second form the head to the ocelli and the propodeum are densely sculptured.

It is easy to postulate intermediates between the second and third forms, especially as the second already has some fine hairs present, but the break between these two and the smooth almost hairless first form is sharp.

(4) The female of *transversinodis* is one of the strangest tetramoriines known (Figs. 22, 24). It is immediately characterized by its broad low occipital flanges or lobes, flattened box-like alitrunk in which the mesoscutum overhangs the pronotum, enormous propodeal lamellae, bilaterally flattened broad petiole on which the ventral process is enormous, and narrow strongly transverse postpetiole which has no ventral process at all.

Two forms of *transversinodis* female are known, distinguished by their radically different pilosity. In the first the entire body is quite densely clothed with curved simple hairs. In the second all such pilosity is absent, being replaced by small scale-like appressed hairs everywhere on the head and body.

The specimens with scale-like hairs are uniform in appearance, but of the specimens with simple hairs a female from Kenya differs from all others seen, which are from the southern half of the region. In the latter the base of the first gastral tergite is shallowly concave across its width, the postpetiole dorsum is not indented medially, pilosity is uniformly short, and the

posterodorsal angle of the petiole does not overhang its posterior face. In the Kenya specimen the first gastral tergite is very deeply and extensively concave basally, the post-petiole dorsum is indented medially, pilosity is long and the posterodorsal angle of the petiole overhangs its posterior face.

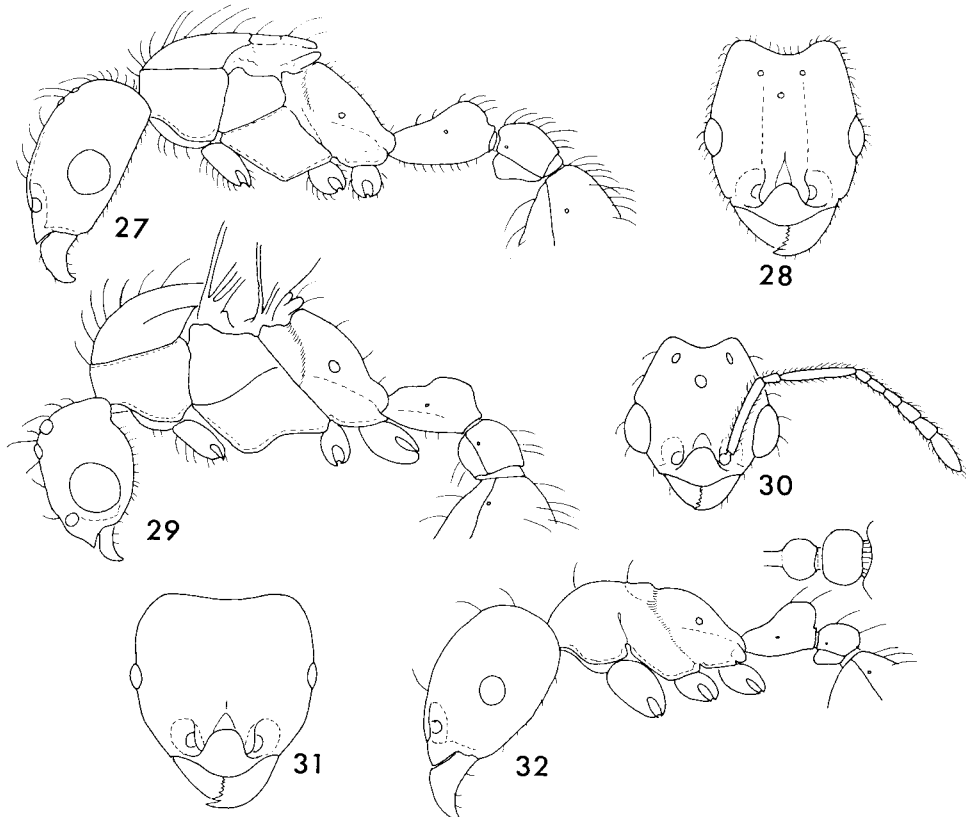
Males. Habitus of known males is relatively stable (Figs. 2, 6, 13, 14, 23, 26, 29, 30). The males of *globulinodis* and *transversinodis* have occipital lobes duplicating those seen in the females but much smaller (Figs. 26, 30). *R. wroughtonii* and *melleus* show propodeal teeth or tubercles (Fig. 13) which correspond to the conspicuous spines of the workers but which are lacking in the females. Strangely, a narrow propodeal tooth is rarely developed in *globulinodis*, in contrast to its female and worker where propodeal armament has never been recorded. On the mesoscutum notauli

vary from conspicuous to absent and wing venation in males is stable and as seen in the females (Fig. 19).

Treatment by species

Rhoptromyrmex caritus sp.n. (Figs. 15, 17)

Holotype female. Mandibles sculptured and with full complement of teeth, the apical tooth enlarged and curved. PF 4,2. Outline shape of head as Fig. 17, the eyes at the midlength of the sides and with numerous short curved hairs projecting between the ommatidia. Occipital margin of head deeply impressed medially. Anterior clypeal margin broadly convex, the clypeus lacking a median longitudinal carina but with fine longitudinal rugulae towards the sides of the central portion. Dorsum and sides of head densely sculptured with irregular but



FIGS. 27-32. *Rhoptromyrmex globulinodis*. 27-28, body profile and head of female; 29-30, body profile and head of male; 31-32, body profile and head of worker. (Scale: Fig. 31 HW=0.82 mm.)

sharply defined rugulae. Head lacking elongate standing hairs of any description but quite densely clothed with short curved to arched pubescence. Shape of alitrunk, petiole and postpetiole as in Fig. 15. Pronotum with a somewhat oblique raised angle or ridge separating its anterior and lateral portions. Propodeum with a pair of flanges running the depth of the declivity and fused to the metapleural lobes below; the propodeum between the flanges deeply transversely concave. Mesopleuron mostly smooth with scattered punctures but remainder of alitrunk, both dorsally and laterally, with dense, sharply defined rugulose to reticulate-rugulose sculpture. Mesoscutum also with a conspicuous median longitudinal carina running its length, which is distinct from the surrounding sculpture. Petiole in profile with a very large, deep keel-like ventral process; the postpetiole with a much narrower elongate process (Fig. 15). In dorsal view the nodes of both petiole and postpetiole strongly rugulose, the former about as long as broad but narrower than the latter, which increases in width from front to back and is broader than long. First gastral tergite shallowly but extensively depressed, the shallow dish-shaped depression occupying the anterior four-fifths of the sclerite. First sternite in profile narrow basally, but behind this distinctly broadly convex. First gastral tergite unsculptured except for numerous small pits from which hairs arise. Erect or elongate hairs entirely absent, but all body surfaces with dense fine short curved pubescence as on the head. Colour light brown, the head and dorsal alitrunk somewhat darker than the sides. Venation as in Fig. 19.

Holotype female (alate), Uganda: Ruwenzori Range, Ibanda, 4700 ft, 20–21.viii.1952 (*D. S. Fletcher*) (BMNH).

Comments. Out of a couple of short series collected in the Ugandan Ruwenzori and deposited in BMNH, this unique female is the only specimen not attributable to *opacus* as that species is currently understood. All the other specimens collected in this area were workers and belong to the relatively weakly sculptured form of *opacus*. The unlikely possibility must be considered that the *caritus* female may be conspecific with these workers, given that in *Rhoptromyrmex* these two castes are usually radically different in morphology and not easily associable. The *caritus* female was,

however, collected in isolation, not in the same series as any of the workers, and is so very different from any other *Rhoptromyrmex* female that I doubt if there is any chance of the workers proving conspecific with it. Nevertheless it may just be possible that two valid species are presently incorporated in the worker caste of *opacus*, but only the collection of series containing both workers and females can solve the problem.

Rhoptromyrmex critchleyi Bolton

Rhoptromyrmex critchleyi Bolton, 1976: 303, Figs. 3, 12. Holotype and paratype workers, NIGERIA: Ibadan, I.I.T.A., no 34G, 23–27. xi. 1973 (*B. Critchley*) (BMNH; MCZ).

Diagnosis of worker. Antennae with 11 segments. Propodeum armed with a pair of spines. Head and alitrunk densely reticulate-punctate. Mandibles unsculptured except for scattered pits. All dorsal surfaces of head and body with short standing hairs. PF 3,2.

Known only from type-series of three workers.

Rhoptromyrmex globulinodis Mayr (Figs. 27–32)

Rhoptromyrmex globulinodis Mayr, 1901: 20. Syntype workers, female, male, SOUTH AFRICA: Port Elizabeth (BMNH; NMV).

Rhoptromyrmex globulinodis st. *alberti* Forel, 1916: 419. Syntype workers, ZAIRE (*Kohl*) (MHN). [Synonymy by Brown 1964: 17.]

Rhoptromyrmex globulinodis var. *obscurus* Santschi, 1932: 389. Syntype workers, male, ZIMBABWE: Vumba Mts, Cloudland, 6000 ft, 6–17.iv.1923 (*G. Arnold*) (BMNH; NMB). [Synonymy by Brown, 1964: 17.]

Rhoptromyrmex globulinodis Mayr Brown, 1964: 17; Bolton, 1976: 302.

Diagnosis of worker (Figs. 31, 32). Antennae with 12 segments. Propodeum unarmed. PF 3,2. Pilosity on alitrunk usually restricted to pronotum. Postpetiole globular in dorsal view; in profile with a blunt ventral process. Sculpture variable but usually sparse and faint dorsally, never blanketed by reticulate-punctate sculpture.

Diagnosis of female (Figs. 27, 28). Head

elongate, more or less flat ventrally; occipital margin concave medially. Eyes hairy and in front of the midlength of the sides. Mandibles triangular, not subfalcate. PF 3,2. Alitrunk elongate and narrow from side to side. Propodeum unarmed, dorsally with a pair of carinae running its length; surface concave between the carinae. Petiole with a long arched ventral keel, the node low. Postpetiole with blunt but conspicuous ventral process. Nodes of petiole and postpetiole longer than broad in dorsal view. Base of first gastral tergite shallowly concave, scarcely broader than postpetiole. All surfaces with dense fine pilosity.

Diagnosis of male (Figs. 29, 30). Head sharply indented in middle of occipital margin so that a lobe is formed on each side. PF 3,2. Eyes with only 1–2 short projecting hairs. Propodeum unarmed but declivity bounded by a pair of short carinae above the metapleural lobes. Petiole node low and rounded in profile. Postpetiole in dorsal view only slightly broader than long. Mesoscutum with notauli present.

Rhoptromyrmex mayri Forel (Figs. 9, 10).

Rhoptromyrmex mayri Forel, 1912: 57. Syn-type females (alate), INDIA: Poona (*Wroughton*) (BMNH; MHN).

Hagioxenus mayri (Forel) Brown, 1964: 19; Ettershank, 1966: 101; Wilson, 1984: 330.

Rhoptromyrmex mayri Forel Bolton, 1979: 173.

Diagnosis of female. Mandibles triangular, not subfalcate. PF 3,2. Head smooth and covered in coarse hair. Eyes with projecting hairs and situated at the midlength of the sides. Occipital margin not deeply indented medially in full-face view. Head smooth, unsculptured. Alitrunk elongate and narrowed from side to side. Propodeum unarmed and declivity lacking longitudinal carinae. Metapleural lobes conspicuous, rounded. Petiole node low and blocky in profile, its dorsal surface approximately flat; ventral process of petiole a long shallow keel. Petiole node longer than broad in dorsal view, postpetiole slightly broader than long and its ventral process low and blunt. Body and appendages densely clothed with long coarse erect hairs. Venation of forewing as in Fig. 19 but with cross-vein m–cu absent. Sculpture vestigial to absent everywhere.

Inquiline in nests of *Pheidole latinoda* Roger. Known only from type-series.

Rhoptromyrmex melleus (Emery) (Figs. 12–14)

Tetramorium melleum Emery, 1897: 586, pl. 15, Figs. 29, 30. Holotype worker, NEW GUINEA: Belaio I., near Madang (*L. Biró*) (TM).

Rhoptromyrmex (Acidomyrmex) melleus (Emery) Emery, 1922: 290.

Ireneella papuensis Donisthorpe, 1941: 175. Holotype and paratype males, NEW GUINEA: Papua, Mafula, 4000 ft, xii.1933 (*L. E. Cheesman*) (BMNH) [Synonymy by Bolton, 1976: 302.]

Rhoptromyrmex melleus (Emery) Brown, 1964: 13; Bolton, 1976: 301.

Diagnosis of worker (Fig. 12). Antennae with 12 segments. PF 3,2. Propodeum armed with a pair of extremely long spines. Pilosity usually restricted to 1–2 pairs on the head and a few on the gaster, generally hairs absent from alitrunk, petiole and postpetiole. Predominant sculpture dense reticulate-punctation, frequently with a few fine longitudinal costulae or rugulae on dorsum of head but never with dense longitudinal costulae.

Diagnosis of female. Head short and broad. Mandibles triangular, not subfalcate. PF not known. Occipital margin shallowly concave, not sharply indented; sides of head almost parallel. Alitrunk compact, broad across the mesoscutum, and the propodeum unarmed. Petiole in profile with a high rounded node and elongate keel-like ventral process. Postpetiole with a short, bluntly rounded ventral process. In dorsal view postpetiole subrectangular, broader than long. Pilosity varying from nearly hairless to moderately dense, but not having coarse stout hairs everywhere.

Diagnosis of male (Figs. 13, 14). Occipital margin of head evenly rounded in full-face view, without lateral lobes. PF 3,2. Eyes with projecting hairs. Propodeum armed with a short blunt tooth or tubercle on each side. Notauli vestigial to absent. Head dorsally and propodeum laterally blanketed with fine dense sculpture.

Brown (1964) gives extensive quotes from the field note-books of E. O. Wilson regarding foraging in this species. In essence *melleus*

nests in the soil and throws up large heaps of excavated soil particles. The ants forage trails are large irregular columns which fan out in the leaf litter and soil, or which ascend trees. A wide range of smaller arthropods were taken as food and the ants also tended homopterous insects both above ground and below.

Rhoptromyrmex opacus Emery (Figs. 1–7).

Rhoptromyrmex opacus Emery in Forel, 1909: 59 (footnote). Syntype workers, CAMEROON (Conradt) (MCSN).

Rhoptromyrmex opacus var. *esta* Forel, 1909: 59. Syntype workers, females, males, ZAIRE: Bas Congo (BMNH; MHN). [Synonymy by Brown, 1964: 15.]

Rhoptromyrmex opacus var. *laeviceps* Sant-schi, 1916: 504. Holotype worker, ZAIRE: Boma (*Bondroit*) (NMB). [Synonymy by Brown, 1964: 15.]

Rhoptromyrmex opacus subsp. *monodi* Bernard, 1952: 251, Fig. 14F. Holotype worker, GUINEA: Mt Nimba, Ziela, st. F32, savana (*Lamotte*) (location of holotype not known). [Synonymy by Brown, 1964: 15.]

Rhoptromyrmex opacus Emery Brown, 1964: 15; Bolton, 1976: 302.

Diagnosis of worker (Figs. 1, 5). Antennae with 12 segments. Propodeum unarmed. PF 4,2. Postpetiole subglobular in dorsal view, slightly broader than long. Sculpture usually of dense reticulate-punctuation all over the head and alitrunk, sometimes overlying fine rugulae also present. In some sculpture on head reduced or even absent; in a few alitrunk sculpture may also be much reduced. Head and gaster always with standing hairs; usually hairs present on alitrunk but frequently reduced to 1–2 pairs or even lacking.

Diagnosis of female (Figs. 3, 4, 7). Microgynous, smaller than worker. PF 4,2. Mandibles subfalcate with oblique masticatory margin. Occipital margin of head not sharply indented medially. Alitrunk short and compact, propodeum unarmed. Petiole node with long low ventral keel. Postpetiole with blunt ventral process. Polymorphic as regards sculpture and pilosity, see discussion of castes above.

Diagnosis of male (Figs. 2, 6). Occipital margin of head evenly convex in full-face view. PF unknown. Eyes with projecting hairs. Pro-

podeum unarmed. Notauli vestigial. Node of petiole in dorsal view broader than long.

Rhoptromyrmex schmitzi (Forel) comb.n. (Figs. 8, 11).

Hagioxenus schmitzi Forel, 1910: 8. Holotype female (dealate), ISRAEL: Jerusalem (*M. Schmitz*) (MHN).

Diagnosis of female. Microgynous. PF 3,2 (*in situ* count). Mandibles subfalcate, masticatory margin not strongly oblique. Petiole node with conspicuous rounded ventral keel. Postpetiole with blunt ventral process. Occipital margin of head not sharply indented medially. Alitrunk short and compact; propodeum unarmed. Pilosity of sparse long hairs.

Inquiline in nests of *Tapinoma erraticum* (Latreille). Known only from the holotype female.

Rhoptromyrmex transversinodis Mayr (Figs. 21–26)

Rhoptromyrmex transversinodis Mayr, 1901: 22. Syntype workers, SOUTH AFRICA: Port Elizabeth (BMNH; NMV).

Rhoptromyrmex steini Forel, 1913a: 122. Syntype workers, SOUTH AFRICA: Lady-smith (*H. Brauns*) (BMNH; MHN). [Synonymy by Brown, 1964: 16.]

Rhoptromyrmex transversinodis var. *pretoriae* Arnold, 1926: 282. Syntype workers, female, male, SOUTH AFRICA: Pretoria, 21.iv.1915 (*C. K. Brain*) (BMNH). [Synonymy by Brown, 1964: 16.]

Rhoptromyrmex transversinodis Mayr Brown, 1964: 16; Bolton, 1976: 303.

Diagnosis of worker (Figs. 21, 25). Antennae with 12 segments. Propodeum unarmed. PF 3,2 (in one worker left maxillary palp with 3 segments right with 4). Metanotal groove usually absent or very faint. Outline shape of petiole node characteristic (Fig. 21). Postpetiole in dorsal view transversely subrectangular, in profile lacking a ventral process. Dorsal surfaces of body from behind clypeus to apex of first gastral tergite lacking standing hairs but with fine appressed pubescence.

Diagnosis of female (Figs. 22, 24). Mandibles narrow, with only 5–6 teeth. PF 3, 2. Sides of head behind eye flattened and produced

into broad blunt lateral occipital lobes. Mesoscutum anteriorly overhanging pronotum. Propodeum with a pair of broad laminae running the depth of the declivity. Subpetiolar process massive, almost as deep as the node is high. Postpetiole without a ventral process, in dorsal view extremely broad. Basal portion of first gastral tergite concave. Pilosity of fine simple hairs everywhere or entirely of minute appressed scales, see discussion of castes.

Diagnosis of male (Figs. 23, 26). Head with a pair of small occipital lobes. PF 3.2. Eyes sparsely hairy. Notauli vestigial to absent. Petiole node in profile rising to a distinct peak posteriorly. Postpetiole transversely subrectangular in dorsal view. Propodeum unarmed. Pilosity simple.

Rhoptromyrmex wroughtonii Forel (Figs. 16, 18–20)

Rhoptromyrmex wroughtonii Forel, 1902: 231. Syntype workers, male, INDIA: Kanara (*Wroughton*) (MHN).

Rhoptromyrmex wroughtonii st. *rothneyi* Forel, 1902: 232 Syntype workers, INDIA: Bangalore (*Rothney*) (MHN). [Synonymy by Brown, 1964: 14.]

Rhoptromyrmex wroughtonii st. *rothneyi* var. *longi* Forel, 1902: 232. Syntype workers, INDIA: Assam, Garo Hills (MHN). [Unavailable name.]

Rhoptromyrmex rothneyi var. *intemedia* Forel, 1913b: 80. Syntype workers, SUMATRA: Beras Tagi, 4500 ft (*Buttel-Reepen*) (MHN). [Synonymy by Brown, 1964: 14.]

Rhoptromyrmex rothneyi st. *sumatrensis* Forel, 1913b: 80, Fig. W. Syntype workers, SUMATRA: Kampong Keling, near Beras Tagi, 4500 ft (*Buttel-Reepen*) (MHN). [Synonymy by Brown, 1964: 14.]

Rhoptromyrmex [sic] *rothneyi* subsp. *leno* Viehmeyer, 1914: 113. Holotype worker, WEST MALAYSIA: Perak (*E. Streese-man*) (location of holotype not known). [Synonymy by Brown, 1964: 14.]

Rhoptromyrmex (*Acidomyrmex*) *rothneyi* var. *taivanensis* Wheeler, 1930: 103. Syntype workers, TAIWAN: Hakuma (*R. Takahashi*) (MCZ). [Synonymy by Brown, 1964: 14.]

Rhoptromyrmex wroughtonii Forel Brown, 1964: 14; Bolton, 1976: 302.

Diagnosis of worker (Fig. 20). Antennae with 12 segments. Propodeum armed with a pair of spines. PF 3.2. Pilosity very variable but hairs usually present on dorsal alitrunk. Sculpture of dense reticulate-punctuation everywhere, overlaid on the head by fine longitudinal costulae which may be very dense.

Diagnosis of female (Figs. 16, 18, 19). Occipital margin of head not deeply indented in full-face view. Mandibles triangular, not subfalcate. Eyes with many outstanding hairs. Alitrunk not elongated and narrowed, nor obviously compact; propodeum unarmed. Petiole node high and narrowly rounded, ventral process of petiole a massive flange. Postpetiole with a long triangular ventral process, the node much broader than long in dorsal view. Pilosity dense and simple everywhere.

Diagnosis of male. Occipital margin evenly convex in full-face view. PF not known. Eyes hairy. Notauli vestigial. Propodeum armed with a short tooth or denticle on each side. Head dorsally and propodeum laterally extensively smooth and shining.

Abbreviations

Abbreviations of museums where type-material is deposited are as follows. BMNH British Museum (Natural History), London, U.K. MCSN Museo Civico di Storia Naturale 'Giacomo Doria', Genoa, Italy. MCZ Museum of Comparative Zoology, Cambridge, Mass., U.S.A. MHN Museum d'Histoire Naturelle, Geneva, Switzerland. NMB Naturhistorisches Museum, Basel, Switzerland. NMV Naturhistorisches Museum, Vienna, Austria. TM Természettudományi Múzeum, Budapest, Hungary.

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Book notices

ATLAS OF NEOTROPICAL LEPIDOPTERA. CHECKLIST: PART 1. MICROPTERIGOIDEA-IMMOIDEA. Edited by J. B. Heppner. Pp. 140. Dr W. Junk, Dordrecht, 1984. (Atlas of Neotropical Lepidoptera) £24.25.

This first part of the checklist heralds the publication of an envisaged 125 volumes of the Atlas of Neotropical Lepidoptera over the next 20 years. Of the total number of 125 volumes, 115 will offer illustrated descriptions of the species treated. There will be one introductory volume and two further volumes will be devoted to a butterfly and moth bibliography for Neotropical species. The checklist will be comprised in six volumes of which this is the first part and covers the first forty-one families of the Microlepidoptera known to occur in the Neotropical region. This first volume includes an outline of the classification of the Lepidoptera, a bibliography and a further generic synopsis. Each part is completed by a species index and an index to genera in addition to the general Checklist index which will be published in Volume 6.

PEST LEPIDOPTERA OF EUROPE WITH SPECIAL REFERENCE TO THE BRITISH ISLES. By D. J. Carter. Pp. 432. Dr W. Junk, Dordrecht, 1984. £59.75.

This guide to the pest Lepidoptera of agriculture, horticulture, forestry, food processing and public health in Europe offers detailed accounts of 228 pest species including information on hostplant range, pest status, distribution and biology and descriptions of eggs, larvae, pupae and adults. The introductory section provides information on methods of identification and control, a resumé of Lepidoptera as pests and a brief historical review of the literature. As the larval stage is responsible for nearly all damage caused by Lepidoptera,

emphasis is placed on identification of larvae, with keys to families and groups of special importance. Although special attention is given to pest Lepidoptera in the British Isles, there is also comprehensive coverage of major pest species occurring in the rest of Western Europe, some 50% of which are known to occur in North America and Japan. The descriptions are illustrated by photographic plates and line drawings. A list of references is provided for each species, which with the comprehensive bibliography completes the work.

MUSEUM COLLECTIONS AND COMPUTERS. By Lenore Sarasan and A. M. Neuner. Pp. 292. Published by the Association of Systematics Collections. 1983. Copies may be purchased from ASC, Museum of Natural History, University of Kansas, Lawrence, KS 66044, U.S.A.

This volume represents the results of a project begun in 1979 to review existing computerized management projects with the purpose of providing guidelines for those museum curators and administrators considering such projects for their own institutions. The volume is divided into four sections. The first (chapters 1-4) provides a report on the results of the project. In this section a brief background sketch is provided and this is followed by chapters discussing the problems encountered, reviewing ways of avoiding problems and concluding with suggestions for implementing projects. Section 2 consists of project summaries standardized from completed questionnaires received by the Association. Section 3 is an annotated bibliography of articles and publications pertinent to museum computerized projects and section 4 indexes the projects summarized in section 2, by project type, software management system and computer hardware used.